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Bell's
Outdoor and Indoor
Experimental
Arithmetics

First Year's Course
(Standard III)

BELL'S Outdoor and Indoor Experimental Arithmetics

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FIRST YEAR'S COURSE (Standard III.)

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FOREWORD.

THE aim of this series is to lead children—by experiment, inference, comparison and contrast—to form a real conception of Length, Area, Weight and Volume.

Each experiment has a definite end in view; either the establishment of an abstract principle, or the practical proof of a theoretical calculation.

The exercises are intended to be taken at times specially set apart for practical work, as it is generally found to be inconvenient to combine practical and theoretical exercises in the same lesson.

They provide, moreover, an interesting and ample course of hand and eye training, which, preceding the theory lesson as it should, has the effect of stimulating the child's activities, and associating in his mind the world of things with the world of ideas.

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OUTDOOR AND INDOOR EXPERIMENTAL ARITHMETIC.

FIRST YEAR'S COURSE.

SECTION I.—LENGTH.

1. The Yard.

The line marked on the playground is 1 *yard* in length.

By means of a tape measure, find

(a) How many inches are contained in 1 yard.

(b) „ feet „ „ „

Record your results thus :

1 yard = ft. = ins.

2. Diagram to shew Yard and Foot.

In your permanent note-books, draw a diagram shewing 1 yard divided into 3 feet, and 1 foot subdivided into 12 inches. (Scale 2 inches to 1 foot.)

3. Measurement of Length of Arm.

Measure the length of your partner's arm from the shoulder

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to the finger-tips (Fig. 1). Compare this length with the yard, as below.



FIG. 1.—Measuring Length of Arm.

Person's Arm.	Length (inches).	Inches in 1 yd.	Difference.
Name of partner		36	
Teacher			

4. Measurement of Length of your Foot.

Measure the length of your foot, and record the number of inches.

5. Number of Foot-Lengths in a given Distance.

By placing the heel of one foot against the toe of the other (Fig. 2), find out how many lengths of your foot are required to make a distance of 2 yards.



FIG 2.—Stepping a Distance.

6. Measurement of Distance by means of your Foot.

(a) Knowing the length of your foot (found in Ex. 4), *calculate* the number of foot-lengths required to make a distance of 3 yards.

(b) From a given starting point, proceed as in Ex. 5, making the number of foot-lengths required. Mark your halting position (toe) with a piece of chalk.

(c) By means of the tape measure, now find out the actual distance you have gone.

Record your results thus :

	Distance.	Length of own Foot.	Number of Foot-Lengths.	Actual Distance.	Amount of Error.
<i>e.g.</i>	3 yds.	7 ins.	15+3 ins. more.	3yds.0ft.10ins.	10 ins.

7. Dimensions of a Brick.

Measure the length, breadth and thickness of a brick. Make a sketch as shewn below (Fig. 3), and put in the *measurements*.

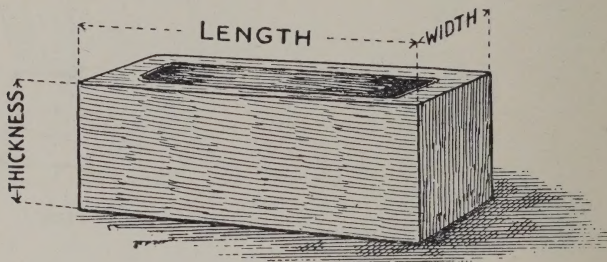


FIG. 3.—A Brick.

8. Drawings, shewing Brick's Dimensions.

In your permanent note-books make three half-size drawings of the brick,

- | | |
|----------------------|---|
| (a) Shewing the top. | } Put in the <i>real</i>
measurements. |
| (b) „ side. | |
| (c) „ end. | |

9. Height of Playground Wall.

- (a) Measure the height of the playground wall.
- (b) Calculate how many bricks make up this height.
- (c) Check your calculation by counting the number of bricks in the height of the wall.

10. Finding Length of Stride.

(a) From the line marked on the playground, walk ten ordinary strides.

(b) Mark your halting position (heel) with a piece of chalk.

(c) With the tape measure, find the distance you have walked.

(d) Calculate the length of one stride.

(e) Repeat the exercise twice more, and compare your results.

11. Striding a Distance.

(a) Knowing the length of one stride (found in Ex. 10 (d)), find how many strides you must take to walk a distance of 30 feet.

(b) From the line marked on the playground, make the number of strides (found in Ex. 11 (a)). Mark your halting position (heel) with a piece of chalk.

(c) By means of the tape measure, find the exact distance.

(d) Make the following table in your note-book, and complete:

	Distance to be stepped.	From Ex. 10 (d).	From Ex. 11 (a).	From Ex. 11 (e).	Amount of Error.
		Length of Stride.	No. of Strides to be taken.	Actual Distance when measured.	
e.g. (1)	30 ft.	2 ft. 6 ins.	12	30 ft. 11 ins.	11 ins.
„ (2)	30 ft.	2 ft. 8 ins.	11 + 8 ins. over	31 ft. 2 ins.	1 ft. 2 ins.

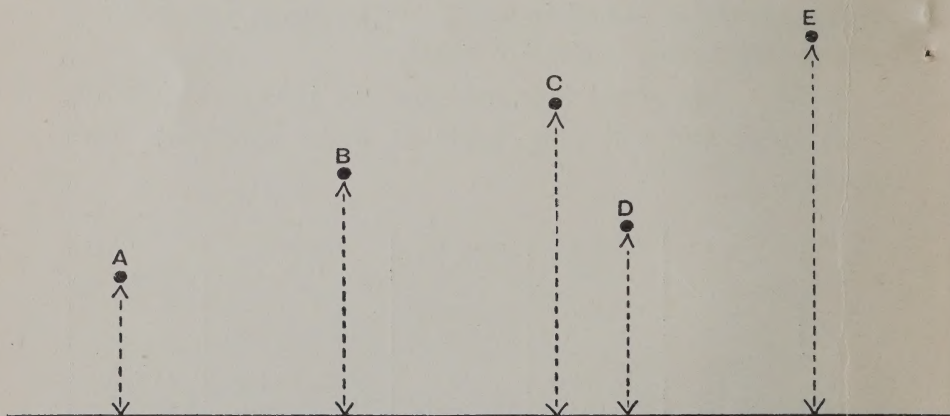
12. Judging Distance.

(a) Judge, as nearly as you can, the distances (in feet) of children, *A*, *B*, *C*, etc., from the line marked on the playground.

(b) With your tape measure, find the exact distance.

(c) Enter your results in the following table, and complete it :

	Name of Scholar.	Distance judged to be	Actual Distance.	Amount of Error.
<i>e.g.</i>	Fred Jones	8 ft.	7 ft. 3 ins.	9 ins.
TOTAL ERROR =				



Line from which distances of Scholars should be estimated.

FIG. 4.—Judging Distance.

13. Estimating Height.

(a) Carefully observe the bottom of the lowest window, and make a sketch as in Fig. 5.

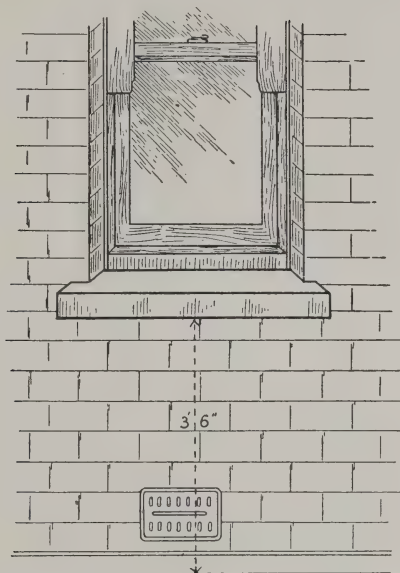


FIG. 5.—Height of Window Ledge.

(b) Estimate its height (in feet) from the playground.

(c) Measure the same; find your error, and record your results as before.

14. Estimating Length.

(a) Estimate, in feet and inches, the lengths of the six pieces of string suspended in front of the class (Fig. 6). (Carefully compare each piece with its neighbour.)

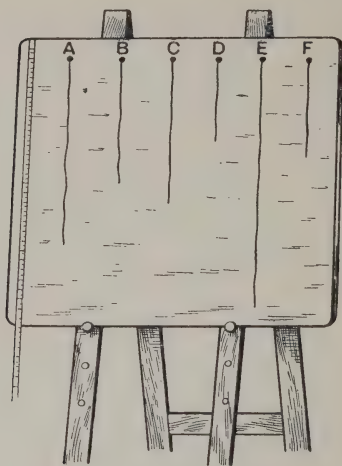


FIG. 6.—Lengths of String.

(b) Make the following table in your note-book, and enter results as you proceed :

String.	Estimated Length.	Length when measured.	Amount of Error.
<i>A</i>			
<i>B</i>			
<i>C</i>			
<i>D</i>			
<i>E</i>			
<i>F</i>			
TOTAL ERROR =			

15. Estimating Dimensions of Boxes.

(a) Estimate to the nearest inch, the length, breadth and depth of the boxes given to you.

Enter your results, as shewn below.

(b) Take the measurements of the boxes ; enter results, and complete the table :

No. of Box.	Exercise.	Length.	Breadth.	Depth.
A	(i) Estimated at			
	(ii) Real size			
	(iii) Amount of error			

16. Estimating Distance round Objects.

(a) Estimate the distance round the *top* of the box which is given to you.

(b) Do the same with the *front* of the box.

(c) Repeat the exercise with the *end* of the box.

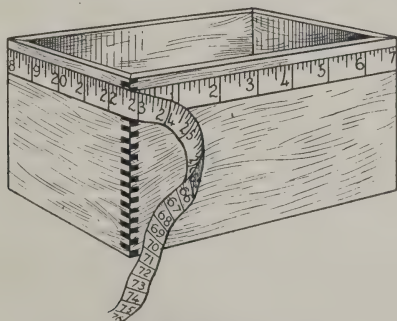


FIG. 7.—Measuring round a Box.

Enter your results.

(d) Measure the lengths you have estimated (Fig. 7), and complete the following table :

Side of Box.	Estimated Distance Round.	Actual Distance.	Amount of Error.
Top			
Front			
End			
TOTAL ERROR =			

17. Graph of own Height.

Make a graph of your height, as shewn by your teacher.

Each boy should measure his partner, but enter his own height.

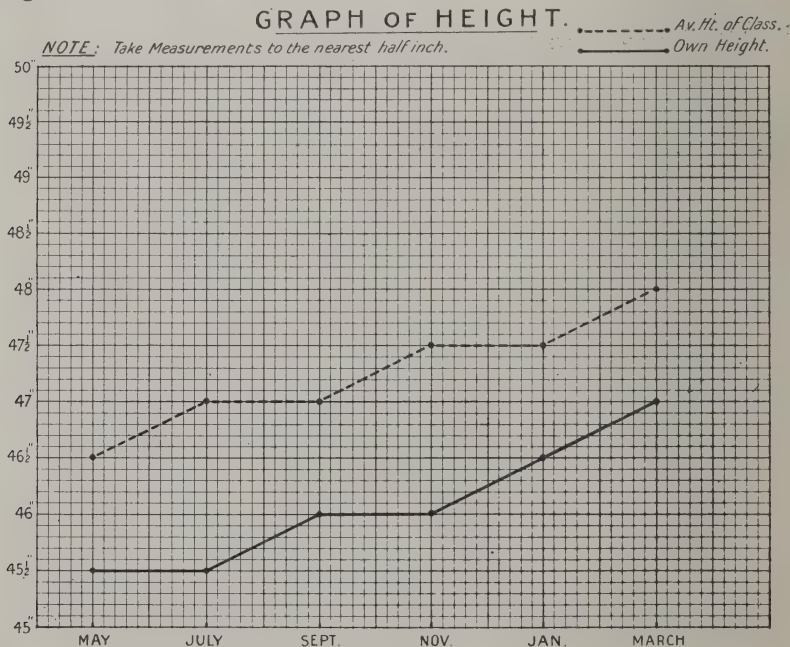


FIG. 8.

SECTION II.—AREA.

18. The Area of a Square.

(a) Make a square with its sides 2 ins. long.

(b) Mark off the middle point in each side, and join as shewn in Fig. 9.

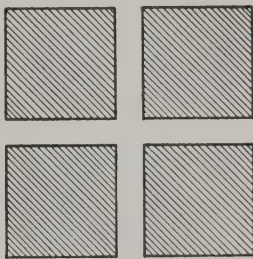
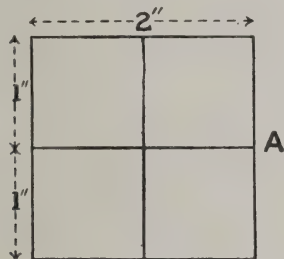


FIG. 9.

(c) Now make a square on tinted paper of 2 ins. side, and cut it into *inch squares* (Fig. 9).

(d) Lay the loose squares over the large square.

(e) Write down the following, and complete the statement :

(i) Length of side of square = inches.

(ii) Size or area ,, = sq. inches.

19. The Three-Inch Square.

(a) Construct a square with sides 3 ins. long (Fig. 10).

(b) Mark off the inches all round, and join the points as in Diagram.

(c) Now make another square of the same size on tinted paper, and cut out the *inch squares* (Fig. 10).

(d) Lay the loose squares over the large square, as before.

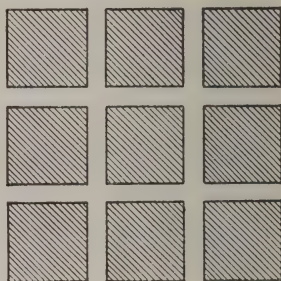
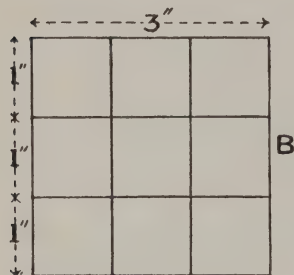


FIG. 10.

(e) Write down the following, and complete :

- (i) Length of side of square = inches.
 (ii) Size or area „ = sq. inches.

20. The Four-Inch Square.

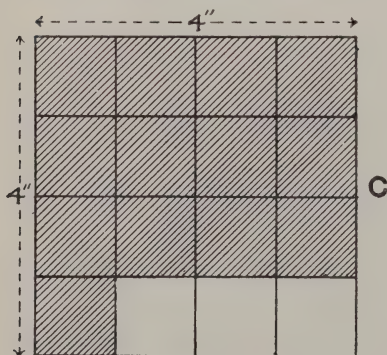


FIG. 11.

(a) Now make a 4 in. square, and mark off into inch squares as before.

(b) Take your loose squares (used in Ex. 18 and 19), and cover as much of your large square as you can.

(c) Write down the following statements, and complete :

- (i) Length of side of square = inches.
 (ii) Size or area of square = sq. inches.
 (iii) Number of loose sq. inches required
 to cover large square = sq. inches.
 (iv) How much larger square *C* is than
 A and *B* put together = sq. inches.

21. Area of other Squares.

Examine your results in Exercises 18, 19 and 20, and then complete the following table, finding also the area of squares which have sides 5 ins., 6 ins., 7 ins., 8 ins., 9 ins., 10 ins., 11 ins. and 12 ins. long.

Length of Side of Square.	Area of Square (in square inches).
2 ins.	$2 \times 2 = 4$ sq. ins.
3 ins.	$3 \times 3 = 9$ „
4 ins.	$4 \times 4 = 16$ „
5 ins.	
6 ins.	
(etc.)	

22. The Square Yard.

(a) Make another square of side 3 ins. long, and let each inch represent 1 foot.

(b) On the class-room floor or blackboard make a square with side 3 feet long.

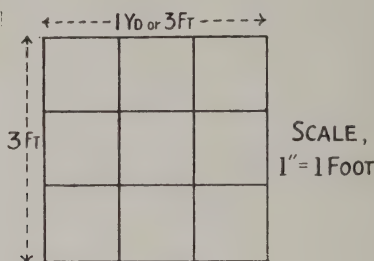


FIG. 12.

(c) Each inch on your paper stands for a foot on the large drawing on the floor or blackboard.

(d) Complete the following :

- (i) Number of feet in 1 yard = feet.
 (ii) „ sq. feet in 1 sq. yd. = sq. feet.

23. The Properties of a Square.

(a) Construct a square with side 4 ins. long, and cut it out. Number each of the corners or angles (Fig. 13).

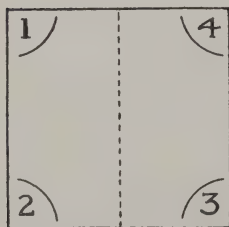


FIG. 13.

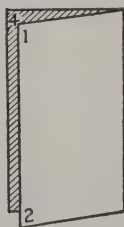


FIG. 14.

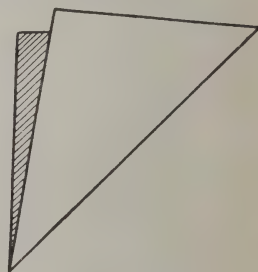


FIG. 15.

- (b) Fold it across the centre, as shewn in Fig. 14.
- (c) (i) How many sides has a square ?
 - (ii) What do you know about their length ?
 - (iii) What do you know about the size of angles 1 and 4, and about 2 and 3 ?
- (d) Now fold the square from corner to corner along the diagonal (Fig. 15).
 - (i) How many angles has a square ?
 - (ii) What do you know about the size of angles 1 and 3, and about 2 and 4 ?
 - (iii) What have you now found about all the angles of a square ?
- (e) Write in your own words what you think a square is.

SECTION III.—VOLUME AND CAPACITY.

24. The One Inch Cube.

(a) Take one of the soap or wood one inch cubes (Fig. 16), and look at it carefully.

(b) In your note-book draw one of its faces, making it exactly the same size as the face of the cube.

(c) Now write in your note-book short answers to these questions :

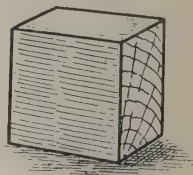


FIG. 16.

- (i) What is the shape of the face you have drawn ?
- (ii) What is its size ?
- (iii) How many faces are there to the cube ?
- (iv) Are all the faces alike ?
- (v) What is the length of each edge of the cube ?
- (vi) How many edges are there ?
- (vii) What would be the total length of all the edges ?
- (viii) What kind of angles has each face of the cube ?

(d) Rule columns in your note-book, as shewn, and enter the first line of results, *leaving room below for future exercises* :

	Object.	Length.	Width.	Height.	Volume.
<i>e.g.</i> (1)	1 in. cube	1 in.	1 in.	1 in.	1 cubic in.
„ (2)	Square tray	2 ins.	2 ins.	2 ins.	
„ (3)	2 square trays				

25. Construction and Volume of Cardboard Tray.

(a) On a square piece of cardboard carefully mark out the figure as shewn in Fig. 17.

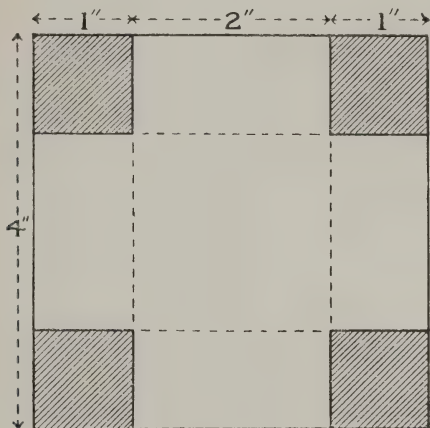


FIG. 17.

(b) Cut out the corner squares, and make a *light* cut along the dotted lines for the purpose of folding.

(c) Bend up the sides (away from the cut), and join the corners, as shewn by your teacher.

(d) Now take the tray you have made (Fig. 18), and place in it as many one inch cubes as you can.

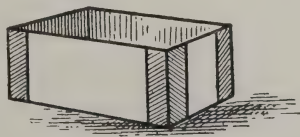


FIG. 18.

(e) In your note-book, make a full-size drawing of the tray, filled with cubes, as seen from above.

(f) If each cube fills one cubic inch of space, how many cubic inches does the tray hold? Write the answer under your drawing.

(g) In the columns ruled for Exercise 24, enter the second row of measurements and results.

(h) The space which the cube or the filled tray occupies is called its *volume*.

26. Volume of Two Trays.

(a) Fill your two trays with one inch cubes.

(b) Place one tray on the top of the other (Fig. 18a).

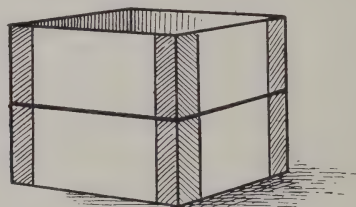


Fig. 18a.

(c) In your book, make drawings (exact size) of the two trays together.

- (i) Looking from above ;
- (ii) Looking from the front ;
- (iii) Looking from one end.

(d) From these drawings, what is the size and shape of each face?

(e) How many inch cubes are there in the two trays?

(f) What is the volume (in cubic inches) of the two trays together?

(g) In your table, used in Exercise 24, enter the third line of measurements and results.

27. Pint and Half Pint.

(a) Take one of the round tins. Look at it carefully, and compare its size with that of either the half-pint or pint measure. You can also compare its size with that of the half-pint glass tumblers in front of the class (Fig. 19).



FIG. 19.

(b) Make a table in your note-book, as shewn below, and write in the second column what you consider to be the size of your tin—that is to say, what you think it would hold, in half-pints or pints.

(c) Now take your tin, and fill it with sawdust, or better still, with fine sand. Then empty it into either the pint or half-pint measure, and find out what it holds.

(d) Enter this result in the third column, and the amount of the error in the fourth column.

	No. of Object.	Estimated Size.	Actual Size.	Amount of Error.
<i>e.g.</i>	7 5	$\frac{3}{4}$ pint $\frac{1}{2}$ pint (nearly)	$\frac{1}{2}$ pint $\frac{1}{2}$ pint (just over)	$\frac{1}{4}$ pint Slight

28. Comparison of Sizes.

(a) Look carefully at the groups of tins in front of the class (Fig. 20).

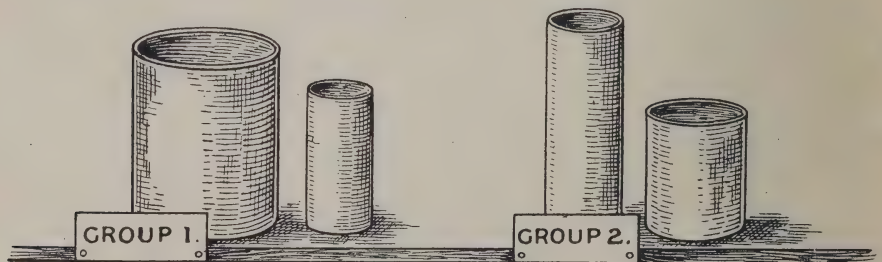


FIG. 20.

(b) In the first group, compare the large tin with the small.

(c) How many times do you think you could fill the small one from the large one ?

(d) In your note-book rule columns, as shewn below, and enter your answer.

(e) Now watch while the large tin is emptied, to see if

your estimation was too great or too small. Enter the correct figures.

(f) Estimate the sizes of the tins in the other groups in the same way.

Group.	Estimated Number of Small in Large.	Actual Number.
<i>e.g.</i> 1 2 3	$3\frac{1}{2}$	$4\frac{1}{2}$

SECTION IV.—WEIGHT.

29. The 1-lb. Weight.

(a) Take the bag of sand, marked 1 lb. (Fig. 21), and hold it in your right hand.

(b) Place your reading book in your left hand, and “balance” them as directed by your teacher.



FIG. 21.

(c) Change book and sand into opposite hands, and repeat.

(d) Which of the two is the heavier?

(e) Write the following statement in your note-book, and fill in either “LESS” or “MORE” in the space shewn.

Reading Book weighs than 1 lb.

(f) Repeat the above exercise, using another reading-book, or your pencil-box.

30. Judging Weight.

(a) Take the box or bag of sand given you, and by holding it in your hands (Fig. 22), form an idea of its weight, as before.



FIG. 22.

(b) Record your result thus :

Box. No. weighs than
1 lb.

(c) Repeat with other objects.

31. Estimating Weight of One Pound.

(a) Take an empty bag, and put sand into it until you think you have 1 lb.

(b) Place this bag of sand in one hand, and a 1-lb. bag in the other.

(c) Which is the heavier ?

(d) Put in, or take out sand, until you get a good "balance."

(e) Weigh the bag to test your result (Fig. 23).



FIG. 23.

32. Half and Quarter Pounds.

(a) On one side of your scales place a 1 lb. weight.

(b) Find how many $\frac{1}{2}$ lb. bags you must place on the other side to make it balance.

(c) Find how many $\frac{1}{4}$ lb. bags are required to balance the $\frac{1}{2}$ lb. weight (Fig. 24).

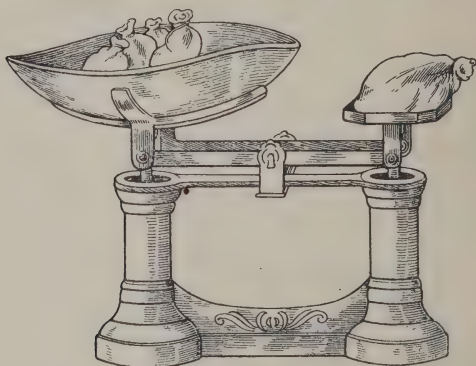


FIG. 24.

(d) Make the following statements in your note-book, and complete them :

- (i) 1 lb. = half-pounds.
- (ii) 1 lb. = quarter-pounds.

(e) Find how many $\frac{1}{4}$ lb. bags are required to balance the $\frac{1}{2}$ lb. weight.

(f) Complete the following statement in your note-book :

- (i) One half-pound = quarter-pounds.

(g) What part of half a pound is a quarter of a pound ?

33. Parts of Two Pounds.

Take a 2 lb. weight. Working as you did in the exercise above, find out

(a) How many half-pounds are contained in 2 lbs.

(b) „ quarter-pounds „ „

(c) What part of 2 lbs. is $\frac{1}{2}$ lb. ?

(d) „ „ „ $\frac{1}{4}$ lb. ?

34. Graph of own Weight.

Make a graph of your weight in pounds as shewn by your teacher.

GRAPH OF OWN WEIGHT.

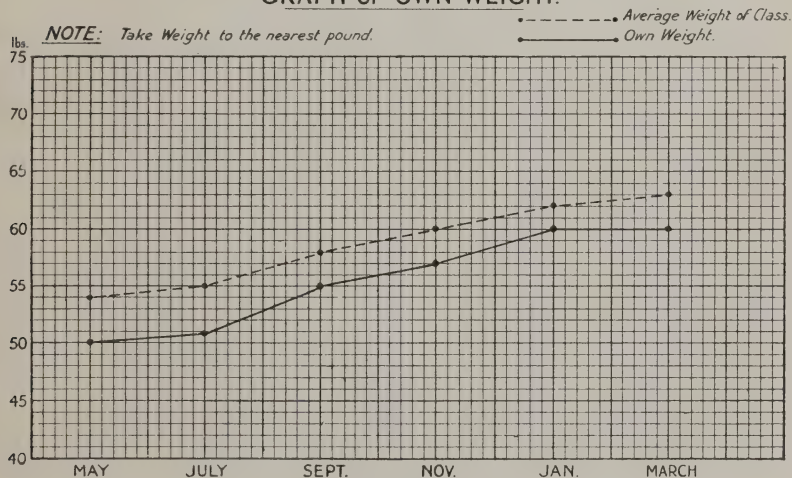


FIG. 25.

SECTION V.—TIME.

35. Practice in Beating Seconds.

(a) Watch the beater carefully (Fig. 26), and count aloud each time it swings.

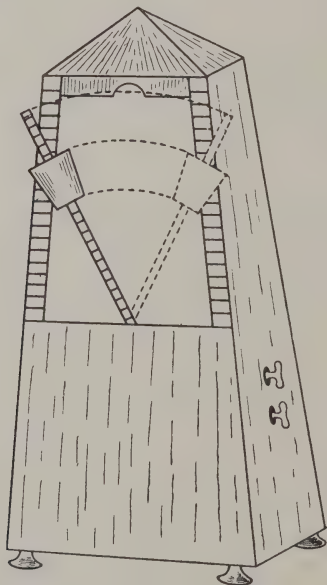


FIG. 26.—The Metronome.

(b) With your right hand, beat time while you count.

36. Finding Number of Beats per Second.

(a) Have ready your note-book and pencil.

(b) Make a small stroke on your book, as shewn below (Fig. 27), each time the beater swings.

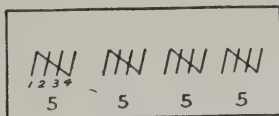


FIG. 27.

(c) Find how many strokes you have made.

(d) Make the following table in your note-book, and complete it :

Number of Strokes.	Time Taken.	Number of Beats per Second.

37. Judging Seconds—by one boy.

(a) Make a stroke in your book (as in Ex. 36) while the boy in front of the class tries to count seconds.

(b) Stop marking when told by your teacher.

(c) Count the number of strokes you have made, and enter as shewn on page 30.

(d) In the next column place the number of seconds, as told by your teacher.

(e) Examine these two results, and in the last column say how the boy was counting—either “too fast” or “too slow.”

	Name of Boy.	Number of Strokes.	Actual Number of Seconds.	Nature of Counting.
<i>e.g.</i>	R. Brown	56	50	Too fast.

(f) Repeat the exercise with other boys counting, and enter results in the above table.

38. Judging Seconds—by the class.

(a) When told to commence, make strokes at the rate of one a second, as nearly as you can judge.

(b) Stop marking when directed.

(c) Count your strokes, and enter in the table below.

(d) In the next column write down the actual number of seconds taken.

(e) State whether your counting was “too fast” or “too slow.”

Number of Strokes.	Actual Number of Seconds.	Nature of Counting.
47	55	Too slow

(f) Repeat the exercise, and add to your results.

HINTS TO PUPILS.

1. Read the exercise carefully until you quite understand it.
2. For outdoor work write down in your rough note-book what you have to do.
3. Where a table is given this should also be copied into your rough note-book.
4. Take all measurements with very great care.
5. When you have finished working the exercise copy it neatly into your special note-book.
6. Keep your bench or desk tidy.
7. When working in groups wait quietly for your turn.
8. Handle all apparatus as carefully as possible.



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